May 26, 1970 A. C. BOGGS 3,513,540

TERMINAL CLOSURE FOR METAL SHEATHED, ELECTRIC RESISTANCE HEATING ELEMENTS

Filed Sept. 6, 1967 2 Sheets-Sheet 1

FIG. 1.

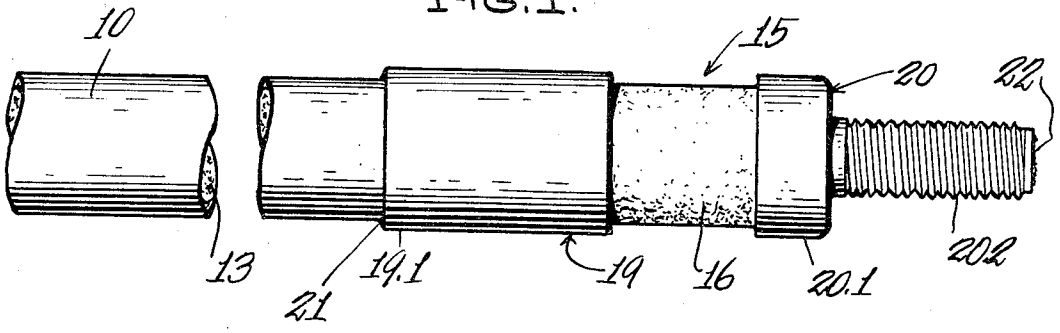


FIG. 2.

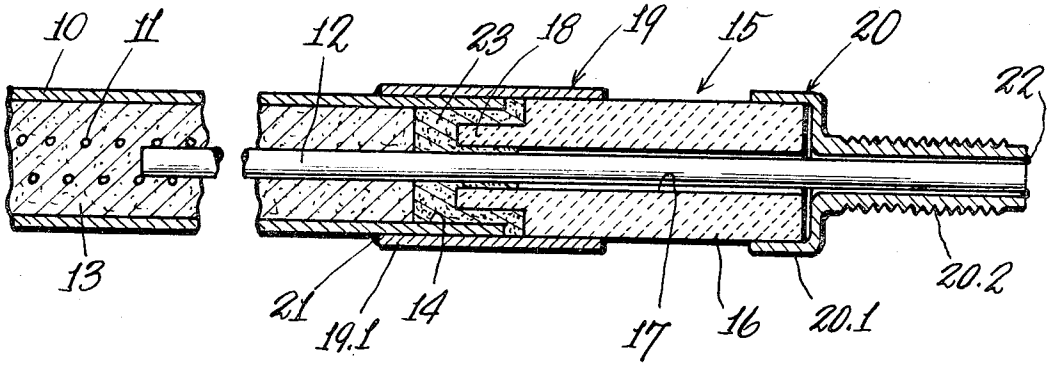
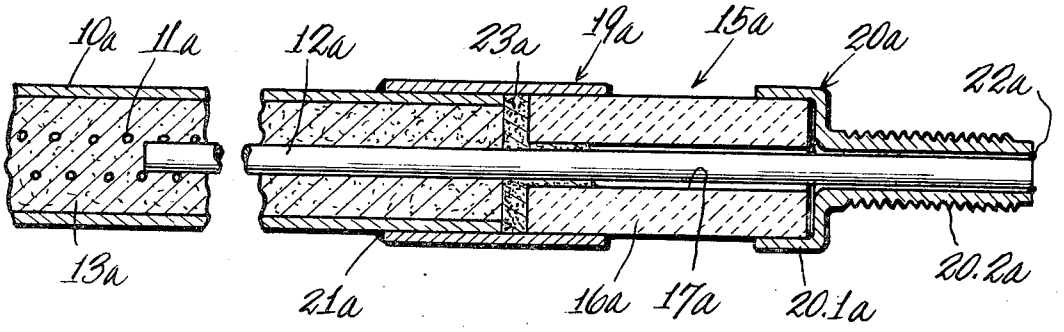


FIG. 6.



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Filed Sept. 6, 1967 2 Sheets-Sheet 2

FIG. 4.

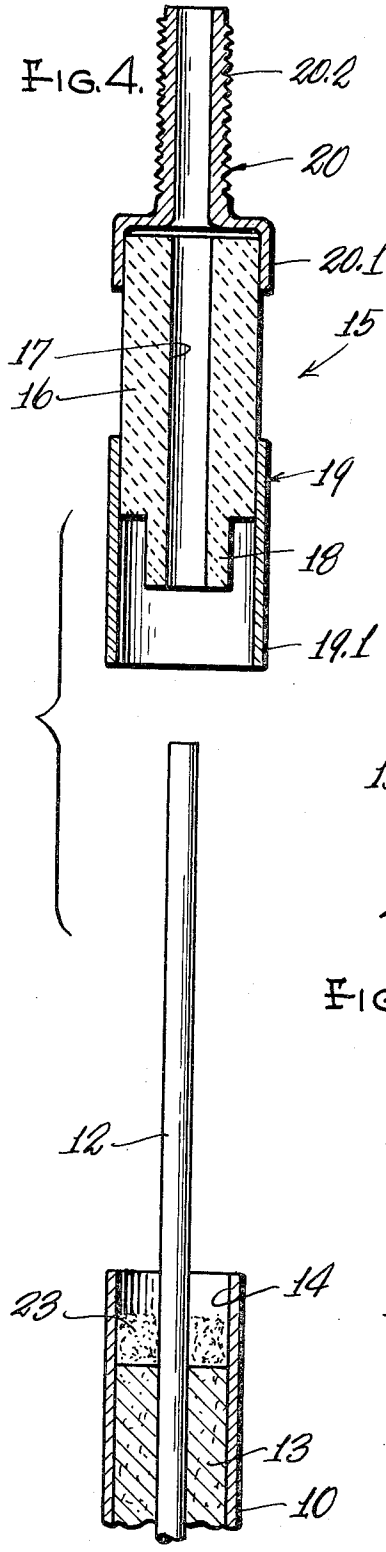


FIG. 5.

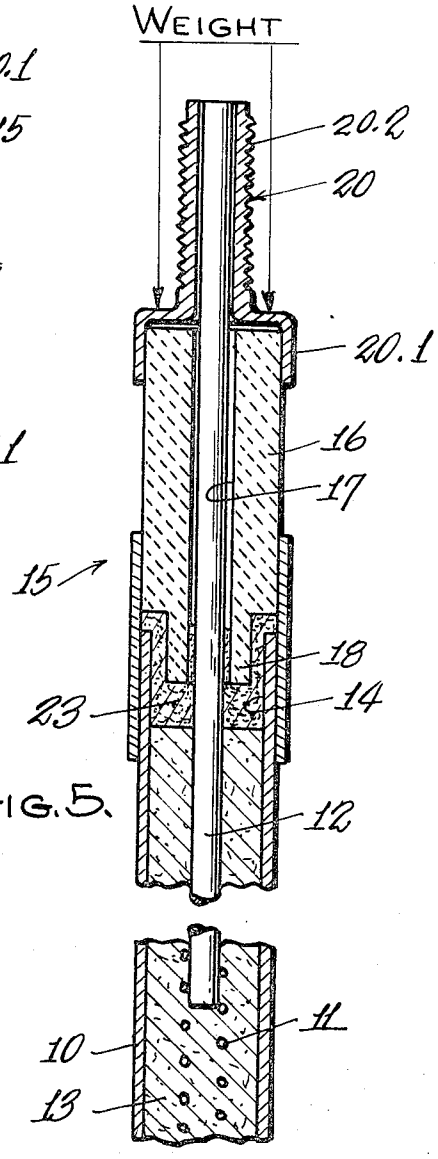
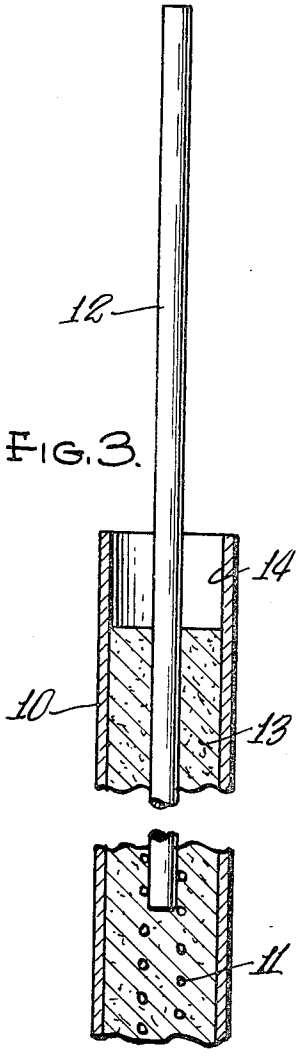


FIG. 3.



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TERMINAL CLOSURE FOR METAL SHEATHED, ELECTRIC RESISTANCE HEATING ELEMENTS

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3 Claims

ABSTRACT OF THE DISCLOSURE

The method of making a hermetically sealed closure at the open end of a tubular, metallic sheathed, electric resistance heating element, and the article produced by such method, which consists of disposing a quantity of flowable, heat-expandable dielectric material at the element open end and between the latter and a closure member, compressing the dielectric material by urging the closure member toward the element end, hermetically securing the closure member to the element sheath to entrap the dielectric material, and applying heat to the assembly to expand the dielectric material in situ.

PREAMBLE

The terminal ends of metal sheathed, electric resistance heating elements, especially those which are hermetically sealed and operate at relatively high temperatures, have presented a manufacturing problem. Not only is the manufacture of such terminal ends expensive, in many cases an electrical breakdown occurs internally of and at the terminal end which renders the element useless. Unfortunately, such breakdowns occur after completion of the element and thus it is a finished element which must be scrapped.

It has long been known that highly compacted, granular dielectric material provides a highly efficient barrier to high voltage. Heretofore, however, it has been impossible to utilize such material at the terminal end of a hermetically sealed heating element since there was no known way to obtain the necessary degree of compaction.

The present invention, by use of a known material in a novel manner, provides an hermetically sealed, metal sheathed, electric resistance heating element having superior resistance to electrical breakdown. This and other advantages will readily become apparent from a study of the following description and from the appeneded drawings.

OUTLINE OF DRAWINGS

In the drawings accompanying this specification and forming a part of this application there is shown, for purpose of illustration, embodiments which the invention may assume, and in these drawings:

FIG. 1 is a broken, side elevational view of the terminal end of an electric resistance heating element embodying the invention,

FIG. 2 is a view in longitudinal section of the heater end seen in FIG. 1,

FIGS. 3, 4 and 5 are sectional views showing various parts at successive stages of manufacture, and

FIG. 6 is a view similar to FIG. 2 but of a slightly different embodiment.

With reference to FIGS. 1 and 2, the heating element fragmentarily shown therein comprises the usual tubular metallic sheath **10** in which a coiled resistor conductor **11** is generally concentrically disposed. Resistor conductor **11** terminates short of the end of the sheath **10** and a terminal conductor member, or pin **12**, is mechanically and electrically secured to the resistor **11** and protrudes axially outwardly of the sheath. The resistor **11** and the

terminal conductor **12** are maintained in spaced relation to the inner wall of the sheath by the usual highly compacted, electric-insulating, heat-conductive refractory material **13**, such as granular MgO, in which they are embedded. In the present embodiment, the refractory material **13** preferably terminates short of the end of the sheath **10** to provide a pocket **14** for a purpose to appear.

Closing the terminal end of the heating element is a closure member assembly **15** (see also FIG. 4) which comprises an elongated, cylindrical ceramic body **16** apertured at **17** to closely receive the terminal conductor **12**. One end of the body is reduced in diameter at **18** to fit within the sheath pocket **14** and a metal sleeve **19** is suitably bonded to the body **16** and has a portion **19.1** preferably overhanging the body end **18** and of a size to slidably receive the open end of the sheath **10**. Suitably bonded to the other end of body **16** is a reducing sleeve **20** having a first portion **20.1** spaced from the sleeve **19** in a direction axially of the body **16** to insure adequate dielectric clearance therebetween, and, also having a reduced diameter portion **20.2** of a size to closely receive the terminal conductor **12**.

With particular reference to FIG. 2, the sleeve end **19.1** is welded, brazed, soldered or otherwise hermetically sealed to the sheath **10** at **21** while the sleeve end **20.2** is similarly secured to the protruding terminal conductor **12** at **22**. To facilitate making an electrical connection, (not shown) to the terminal conductor, the sleeve end **20.2** may be externally threaded as shown.

Disposed in the previously mentioned sheath pocket **14** and filling the space defined by the latter and the body end **18** is a compacted mass of dielectric, heat-resistant material **23** which prevents an electrical breakdown, or short circuit, between the terminal conductor **12** and the sheath **10**. At the present time and because of its peculiar expansion properties later to be disclosed, material **23** is finely divided vermiculite.

In the manufacture of the assembly seen in FIGS. 1 and 2, the electric heating element, less the closure member assembly **15**, will be disposed with its terminal end in upright relation as shown in FIG. 3. It will be understood that the refractory material **13** will have previously been highly compacted in the usual manner in the sheath to embed the resistor conductor **11** and the terminal conductor **12** therein. A quantity of finely divided vermiculite in concentrate (or unexpanded) state, as marketed by the W. R. Grace & Co. of Chicago, Ill., and described in their brochure G–201 revised 1961 and 1963, is then disposed in the sheath pocket **14** as illustrated in FIG. 4. The closure member assembly **15** will then be slid over the terminal conductor **12** with the body portion **18** in the sheath pocket and resting upon the mass of vermiculite **23** and with the closure member sleeve **19** about the element sheath **10** as shown in FIG. 5.

The closure member **15** and element will then be forced together, as by application of weight to the closure member, to compress the vermiculite mass **23** and cause it to fill the interstices between the closure member and the adjoining end of the element assembly. With the parts thus assembled, the sleeve end **19** is fused to the sheath by the weld or solder **21** to form a hermetically sealed juncture therebetween.

With the closure member thus secured to the sheath, the force or weight urging the closure member toward the element end may then be removed and the assembly will next be disposed in an oven and subjected to sufficient heat for a sufficient length of time to drive off any moisture trapped within the element sheath and to cause expansion or exfoliation of the entrapped vermiculite mass **23**. Expansion of the mass **23**, since it is in a confined space, will have the effect of greatly increasing the com-

pression thereon and will insure that no voids exist across which an electric current might jump between the sheath **10** and the terminal conductor **12** or between the latter and the sleeve **19**.

After the moisture has been driven from the heater and the mass of vermiculite has been expanded, the assembly will be removed from the oven and preferably permitted to cool in a moisture-free atmosphere. Upon cooling, the sleeve **20** will be fused to the terminal conductor **12** by weld or the like **22** to form a hermetically sealed juncture therebetween.

While only one element terminal end has been disclosed, it will be understood that the usual element has two ends, each of which will preferably be sealed in the manner hereinbefore disclosed.

The embodiment of FIG. 6 is similar to that heretofore disclosed; accordingly, corresponding parts are identified by the same reference characters but with the suffix *a* added. In this embodiment, the pocket at the open end of the element sheath has been omitted; that is, the compacted refractory material **13***a* extends all the way to the end of the element sheath **16***a*. Moreover, the reduced diameter end of the closure member ceramic body **16** is omitted and such body end is merely disposed adjacent the sheath end with the mass of vermiculite intervening.

During assembly of the embodiment seen in FIG. 6, since there is no pocket at the sheath end in which the mass of vermiculite may be disposed prior to assembly of the closure member with the element, the vermiculite may merely be deposited in a mass at the end of the element and about the terminal conductor. Alternatively, during assembly of this embodiment, the closure member may be inverted from the position seen in FIG. 4, and the vermiculite may be deposited in the closure member end within the pocket provided by the member sleeve **19***a* and the adjoining end of the member ceramic body **16***a* prior to assembly of the closure member with the element end. Thereafter, assembly of this embodiment may proceed in the manner previously outlined.

While manufacture of a hermetically sealed heating has been disclosed, it will be understood that the invention may find application where a hermetically sealed heating element closure is not required.

In view of the foregoing it will be apparent to those skilled in the art that I have accomplished at least the principal object of my invention and it will also be apparent to those skilled in the art that the embodiments herein described may be variously changed and modified, without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described; hence it will be appreciated that the herein disclosed embodiments are illustrative only, and that my invention is not limited thereto.

I claim:

1. The method of making a closure at the open end of a tubular, metallic sheathed, electric resistance heating element having a terminal conductor embedded in compacted, electric-insulating, heat-conducting refractory material within the sheath and protruding from an open end thereof, which method comprises entrapping a quantity of granulated vermiculite surrounding said terminal conductor in a space formed by said open end and a closure member fitting the same, forcing the closure member and the sheath together to decrease the size of the space and compress the vermiculite therewithin, and applying heat to said heating element to exfoliate the vermiculite.

2. The method of claim **1** and further including the step of securing said closure member to said heating element in hermetically sealed manner.

3. The method of claim **1** wherein said closure member includes a metal sleeve having one end closely fitting around the sheath open end, a ceramic sleeve having one end closely fitting within the other end of said metal sleeve and hermetically sealed thereto, a tubular metallic terminal having one end closely fitting around the other end of said ceramic sleeve and hermetically sealed thereto, said space being formed by said open sheath end, the interior of said metal sleeve and the adjoining end of said ceramic sleeve with said terminal conductor loosely fitting through said space and through said ceramic sleeve and said tubular metallic terminal, said method including the further steps of fusing said metal sleeve to the exterior of said sheath to form a hermetic seal therebetween after said vermiculite has been compressed, thereafter applying heat to said heating element to first remove moisture entrapped within said heating element and to then cause said exfoliation of said vermiculite, said moisture being vented through space between said terminal conductor and said metal sleeve, said ceramic sleeve and outwardly through said tubular metallic terminal, and thereafter fusing said terminal conductor to said tubular metallic terminal effect a hermetic seal therebetween.

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U.S. Cl. X.R.

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